

# Development & complexity

Owen Barder



Hello, my name is Owen Barder at the Center for Global Development in Europe.

This presentation is about the implications of complexity theory for economics in general, and especially for development.

# Outline

- 1. The toaster project**
- 2. Conventional economic models**
- 3. Adaptation and coevolution**
- 4. Complex adaptive systems**
- 5. Seven policy implications**

We are going to begin with the true story of British design student who tried to make a toaster from scratch. It may seem whimsical, but the story sums up many of the arguments in this talk.

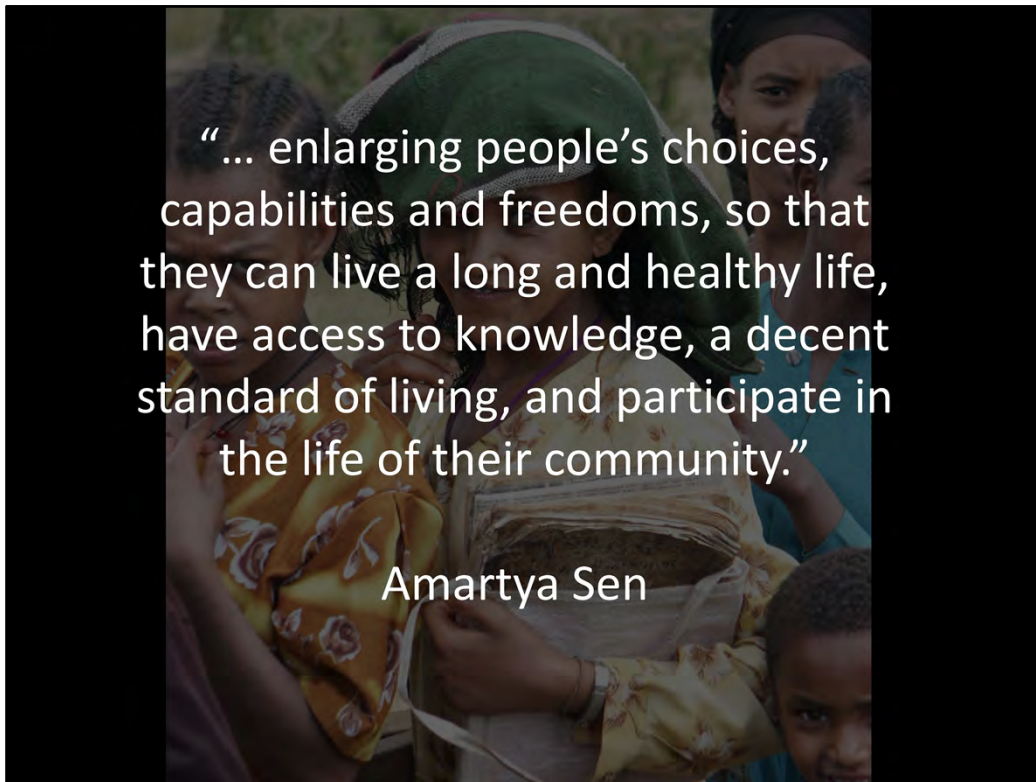
Then we are going to review the way that development economists have modelled economic growth and development over the last sixty years. We will look at how this has set us off on a fruitless quest for the missing ingredient which will enable poor countries to grow.

Then in the third and fourth parts of the talk, we will look at some new thinking in economics which looks at the way that technologies, people, firms and institutions adapt and evolve, and how the interaction of these adaptive agents create what is known in physics and biology as complex adaptive systems.

In the fifth and final section, we will explore what all this means for development policy. Once we think of development as a system property, and not the sum of what happens to the people and firms in the economy, we get some new insights into how we can accelerate and shape development.

This is all quite dense, which is why this presentation is online in a form which

enables you to skip around using the controls on the left hand side.



My talk today is about this young woman and many more young women around the world like her. We met her in Gojam, a part of Ethiopia famous for its farming. The day I took this picture, we asked her what she wants to be when she grows up. She said she wants to be a doctor.

In his book 'Development as Freedom' the Nobel prize winning economist, Amartya Sen, defines development as:

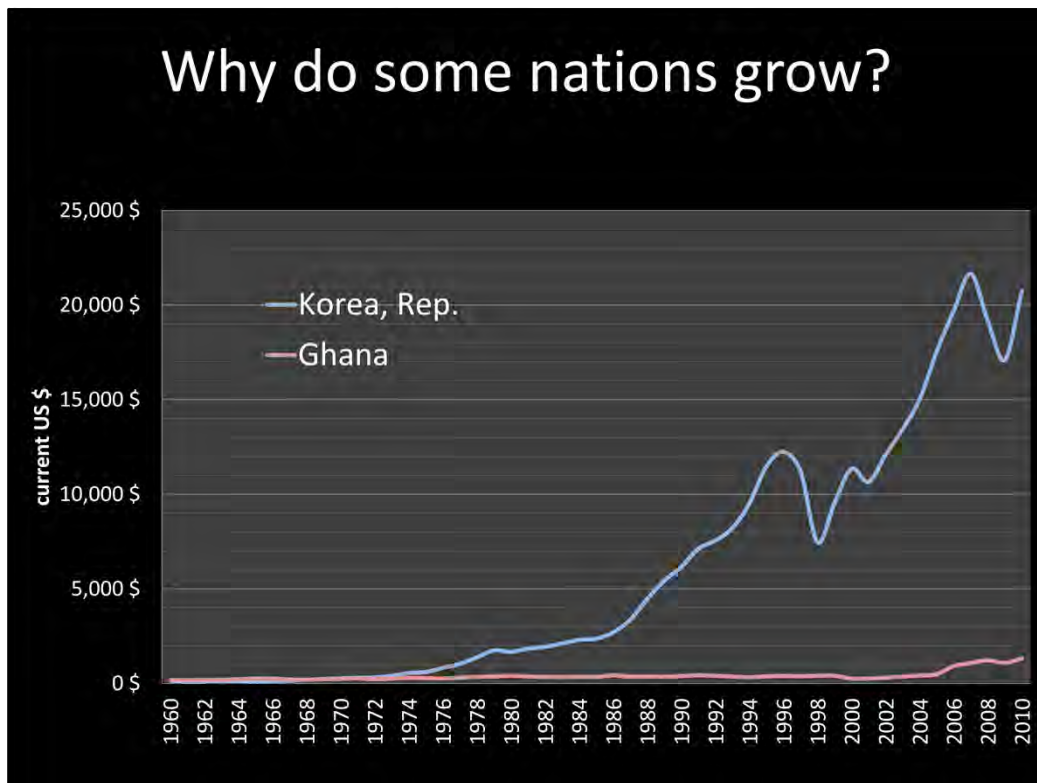
*“enlarging people's choices, capabilities and freedoms, so that they can live a long and healthy life, have access to knowledge, a decent standard of living, and participate in the life of their community.”*

There is now widespread acceptance of Sen's view that development should be judged not only on the basis of increases in average incomes, but on whether it creates the circumstances for people like this young woman to exercise their choices, capabilities and freedoms.

But judging development by its effects on people does not mean that development is the sum of improvements in the well being of people or the output of firms. In this talk I argue that we should think of development as a property of the economic

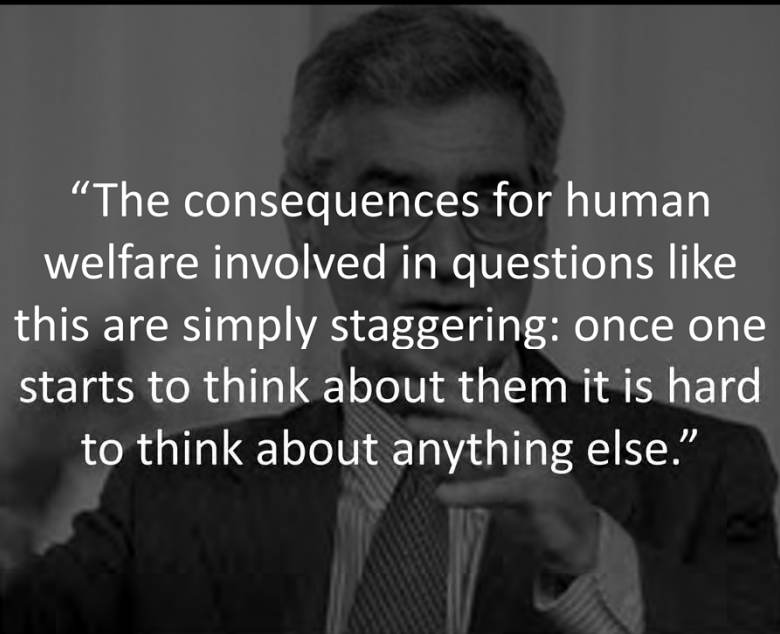
and social system itself.

# Why do some nations grow?



This is a famous comparison of what happened to people's incomes in two countries which had roughly the same income per person in 1960. For most of the 1960s, South Korea, shown here in blue, had lower income per person than Ghana, shown in pink. But in the late 1970s incomes in South Korea really began to take off; while in Ghana, at least until recently, they have stayed roughly the same.

It is important to say that average income per person is not a complete measure of well-being. Amartya Sen has played a key role in helping us understand the multi-dimensional nature of poverty and development, and we are concerned about distribution and not just averages. But even so, this difference in economic growth has resulted in a complete transformation in the lives of the people of South Korea. The important question is: why has this happened in South Korea but not in Ghana?



“The consequences for human welfare involved in questions like this are simply staggering: once one starts to think about them it is hard to think about anything else.”

Robert Lucas

This is another Nobel prize winning economist, Robert Lucas. Here is what he said about this question.

“The consequences for human welfare involved in questions like this are simply staggering: once one starts to think about them it is hard to think about anything else”.

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1. **The toaster project**
2. **Conventional economic models**
3. **Adaptation and coevolution**
4. **Complex adaptive systems**
5. **Seven policy implications**

We are going to look shortly at traditional economic models which are based on the idea that development is a gradual process of firms becoming more productive, and household incomes gradually rising, creating the opportunities which enlarge people's choices, capabilities and freedoms.

Before we do, let's look at a story which illustrates the hypothesis of this talk, which is that development is better thought of as a characteristic of the economic, social and political system, not simply the sum of the well-being of the people in it.



# The toaster project

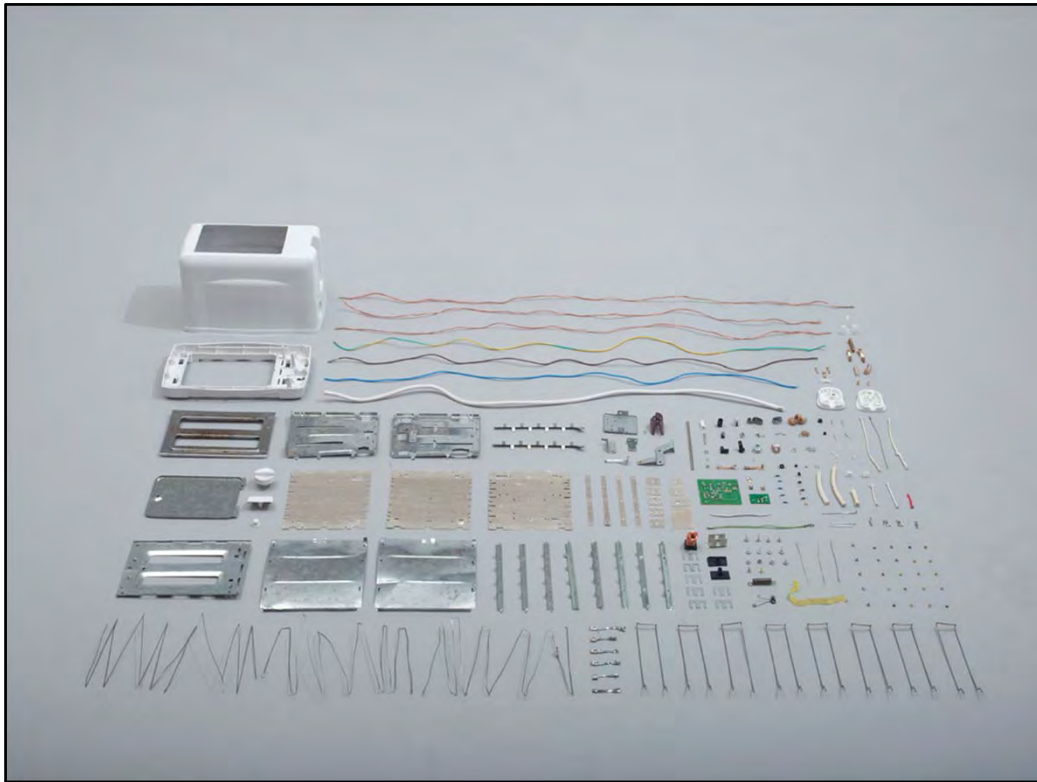


*Thomas Thwaites*

Three years ago, a British design student called Thomas Thwaites decided that he was going to try to make an electric toaster entirely from scratch, finding the raw materials and turning them into parts.

First he needed a model to work from so he went to Argos, which is a high street chain in Britain. Argos currently stocks 101 different toasters.

Not wanting to make things harder than necessary, Thomas Thwaites bought the cheapest, simplest toaster in the store. It cost £3.94, which is less than five euros or about six US dollars.



It turns out that even the simplest toaster is actually quite complicated. There are about 400 parts, made from more than a hundred different materials, like steel, copper, rubber, mica and plastic.

So remember, Thomas Thwaites is going to try to make each of these parts from scratch. As you can see, there is a fair bit of steel here, so the first thing he did was to go to an iron ore mine to get some iron ore, to smelt into steel.



When he arrived at the mine, he found that there had been a misunderstanding. They thought he was going to make a poster, not a toaster. Once they had sorted that out, they gave him some iron ore, and he put into his roller bag and took it back to London.



Unfortunately he didn't have a steel smelter at home so he decided to use his rubbish bin.

Nor did he have any bellows, so he used his leaf blower, here on the left of the picture, instead.

He tried this for several hours but he couldn't get it hot enough.

He was going to give up completely.

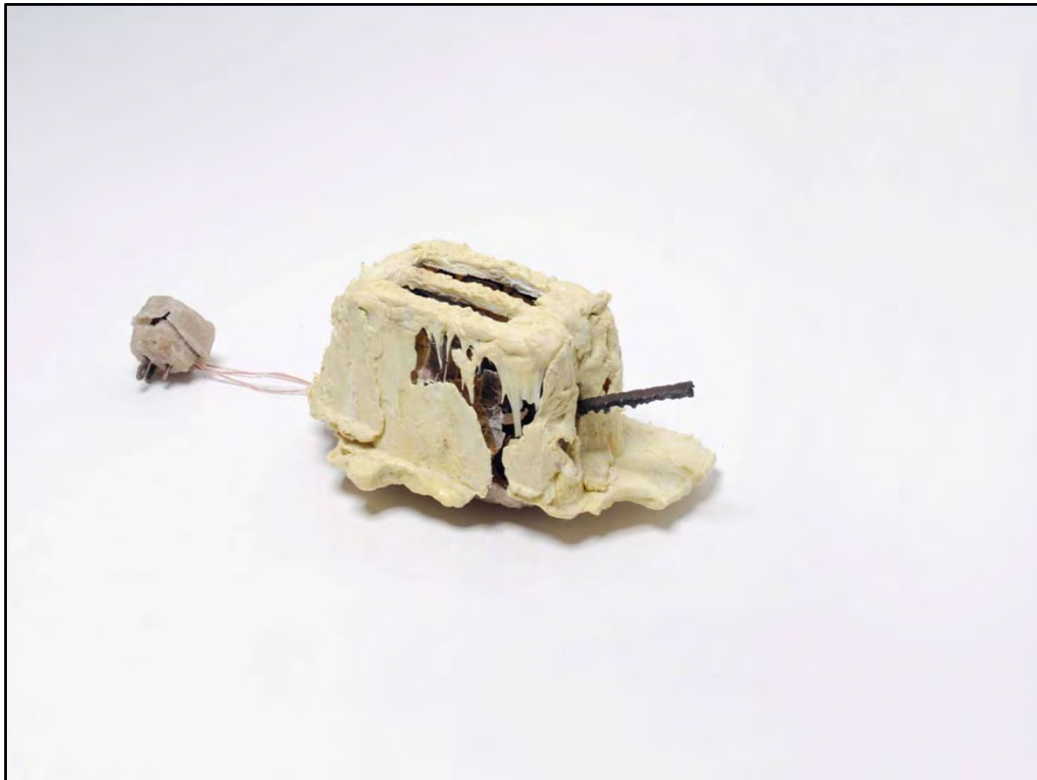


Until he discovered on the internet that you can smelt steel by putting it in a microwave for half an hour. And that is what he did. Success.



I won't go through all the other things that Thomas Thwaites had to do to make his toaster. He did try to go to an oil rig to get a jug of oil to make some plastic, but BP would not let him. So he melted down old discarded plastic, and used a wooden mould to make the plastic casing of the toaster.

And here it is.



It took Thomas Thwaites nine months to make this toaster, and a huge cost as he tried to assemble all the materials and fashion them into the parts he needed. Unfortunately he wasn't able to get hold of any rubber, so the copper wires were not insulated. When he plugged in his toaster, the toaster worked for five seconds, and then it burst into flames. Thomas Thwaites later called this 'a partial success'.

The point is that even building something as common and cheap as a 5 euro toaster requires a whole array of technologies and parts. The economy has to be sufficiently sophisticated and rich to be able to supply all these different materials and parts – and of course if you are going to make a business making toasters you are going to need electricity, a workforce, some way of transporting your goods, a legal system to enforce contracts, a functioning financial system to provide capital, and so on.

What this points towards is the idea that development is not an increase in output by an individual firm; it is the emergence of a system of economic, financial, legal, social and political institutions, firms, products and technologies, which together provide the citizens with the capabilities to live happy, health and fulfilling lives.



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That is absolutely not how economists have treated economic development over the last 60 years in their economic models. We are going to look now at how economists have constructed development as being the sum of what happens to individuals and firms in the economy.



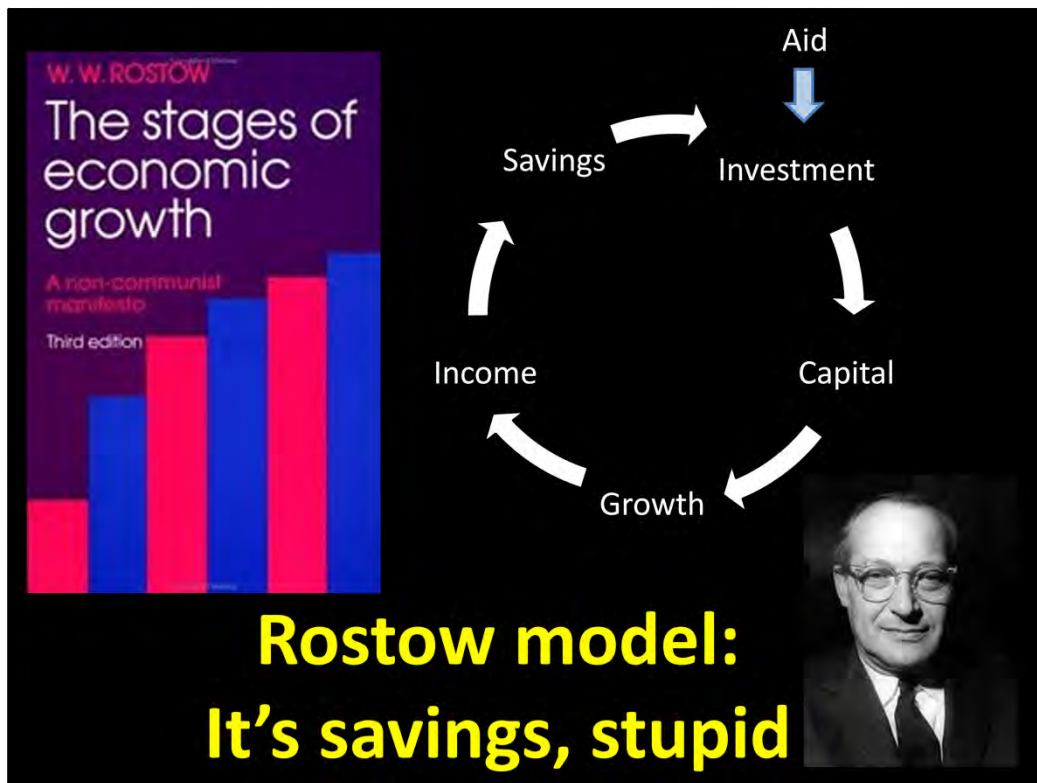


For most of the last six decades, economists have treated the terms 'economic growth' and 'economic development' as more or less synonymous.

After the second world war, economists relied on a very simple model called the Harrod – Domar growth model. This said that to make a unit of output – say, a yard of cloth – you need to combine a certain amount of capital – in the case, a loom – and a certain amount of labour – in this case, the time of a weaver.

According to this simple model, a firm increases its output if it can increase the amount of capital it uses and the amount of labour it uses.

And since the economy as a whole is assumed to be the sum of the firms within it, to increase the output of the whole economy, you similarly need either more capital or more labour. Since developing countries did not seem to be short of surplus labour, it seemed to be capital that was constraining them.



In 1960 Walter Rostow published *The Stages of Economic Growth* which claimed that development is a virtuous circle: when investment rises, that means that the capital stock rises, so output rises, leading to higher incomes, more savings, and so more investment.

Rostow calculated that for most poor countries, if you could increase investment by 5 or 10 per cent of national income this would trigger this virtuous circle and launch the country into 'self-sustained growth'

Rostow's model was hugely influential, not least as a rationale for foreign aid in much of the 1960s and 1970s. Once you know the investment you need to get lift off, you can calculate the amount of foreign aid that is needed to fill the gap between domestic savings and the level of investment you need.

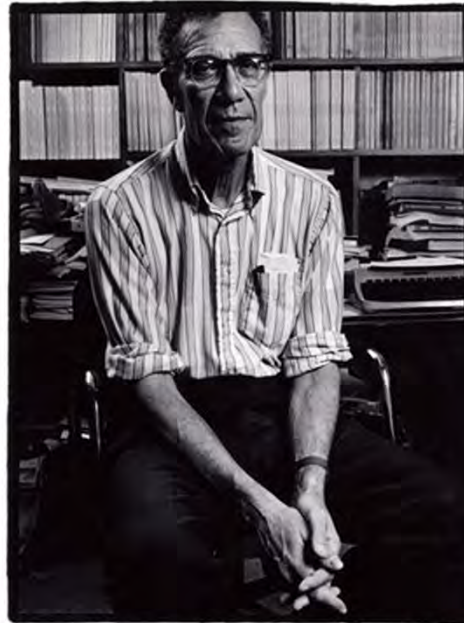


One you have worked out how much additional investment a country needs, you can then use aid to finance big infrastructure projects like dams and roads.

It seems absurd that this was the intellectual underpinning of aid for so long; but don't underestimate how influential this model has been. It is still used today by donors like the World Bank to calculate financing gaps.

# Robert Solow

- Neoclassical growth theory
- Exogenous technical change



Robert Solow, Nobel Laureate

Cambridge, 1987

One slight drawback with the Harrod – Domar model is that it bears no resemblance to reality. When you look at the figures for capital and labour, you cannot construct an explanation of why South Korea grew so fast and Ghana did not.

In the late fifties Robert Solow introduced what is now known as the **neoclassical growth model**. It introduced a third component, on top of labour and capital, which he called '**technical change**'. Now he didn't attempt to explain where this technical change comes from: it is treated in the model as '**mana from heaven**' – a magic ingredient which, when combined with labour and capital, increases the output of each firm.

The good news is that Solow's model fits the data much better than the old Harrod-Domar model. The bad news is that it really isn't a model at all: it is just a form of accounting which breaks growth down into increases in labour, increases in capital, and some other, unexplained component that he calls 'technical change'.

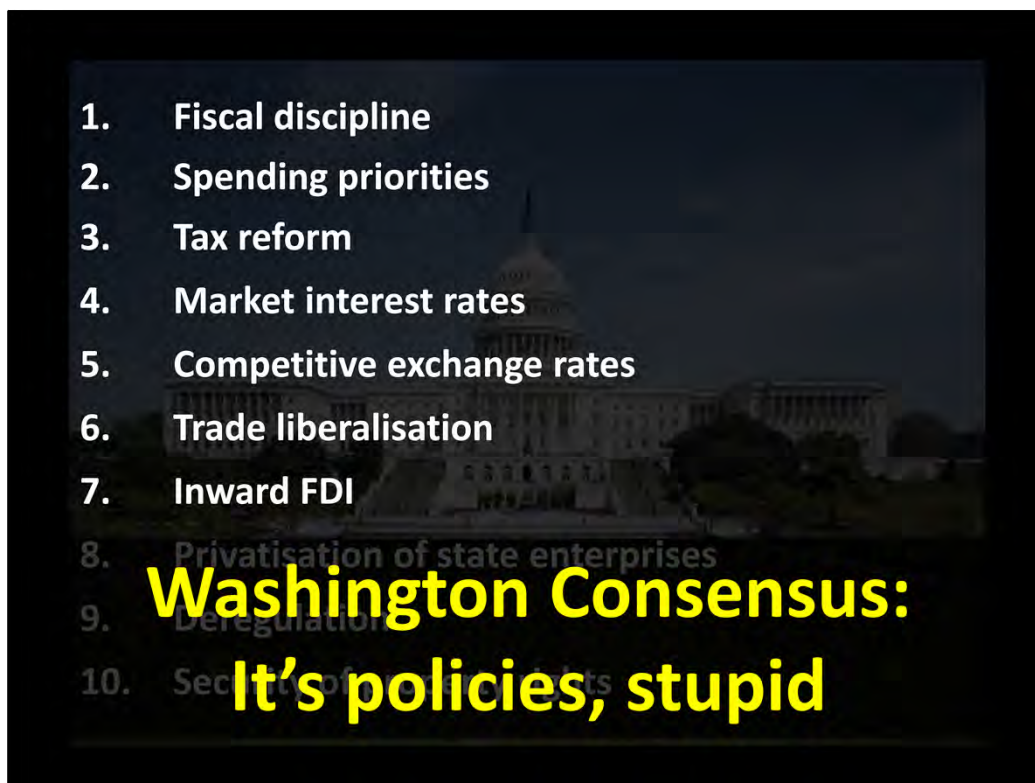




The main problem with Solow's model is that it turns out that the interesting part is nearly all in this 'unexplained' bucket. When you run the numbers against what actually happened in different countries, the Solow framework tells us that the divergence between rich countries and poor countries is entirely explained by the fact that sub-Saharan Africa has had negative growth in this unexplained 'technology' component, while the countries of East Asia, for example, have had positive growth.

When you think about it, it does not seem likely that technology or knowledge is the basis of the difference. For a start: why wouldn't technology spread, so that poor countries catch up? Unlike labour and capital, knowledge is cheaply reproduced. Furthermore, it has this characteristic that if I use an idea, that doesn't diminish your ability to use the same idea, so given that there is no cost to us sharing the knowledge, you would expect it to spread.

If you want to believe that technological change is the unexplained component, you are going to have to believe that it has been sharply diminishing in Africa over the last thirty years. Now, it isn't entirely impossible for some countries to lose some of their social capital – for example if there is a period of civil war or if the population declines sharply. But you it does not seem very likely that this is the main explanation for economic divergence between rich countries and poor countries.



By the late seventies, people were beginning to notice that our models of economic growth were not working.

Economists were undaunted. They argued, in effect, that their model correctly predicted *potential* of each firm, and so of the economy as a whole; but that because of a series of failures of *policy* the country wasn't living up to this theoretical potential. In other words, bad government policies interfered with the proper functioning of markets and that meant that output was lower than it should be.

So institutions like the World Bank and the IMF began to propose a series of policy reforms, often summarised as these ten items which became known as the Washington Consensus.

Most people today say the Washington Consensus was a failure. Efforts to free up markets did not lead to convergence of poor countries on the industrialised world in the ways that were supposed to.

On the other hand, some of the reforms which were introduced at this time, particularly in sub Saharan Africa, such as bringing down public deficits and liberalising exchange rates, may have helped to improve the economic performance of those countries over the last twenty years.

But if the difference between rich countries and poor countries is not failures of policy, then what is it?

## Ajaokuta Steel Works



**Post Washington Consensus:  
It's institutions, stupid**

This is Ajaokuta Steel Works in Nigeria. It is one of the largest ever investments in steel production anywhere in the world. The investment cost more than 5 billion US dollars and it is costing the Nigerian taxpayer about 29 million dollars a year just for wages. According to economic models, you have labour and you have capital so you should have output and growth. But Ajaokuta has so far produced no steel at all.

So why hasn't Ajaokuta added to Nigeria's national income? The answer is poor management and endemic corruption.

Once it became clear in the 1990s that the Washington Consensus was not working, the development business decided that the problem was not *policies* but *institutions*. This has taken various forms, including huge aid spending on technical cooperation, institutional strengthening, and various kinds of capacity building. Globally technical cooperation alone accounts for about \$21 billion a year. The UK Department for International Development now has more governance advisers than economic advisers, and it spends nearly a fifth of its budget on governance.

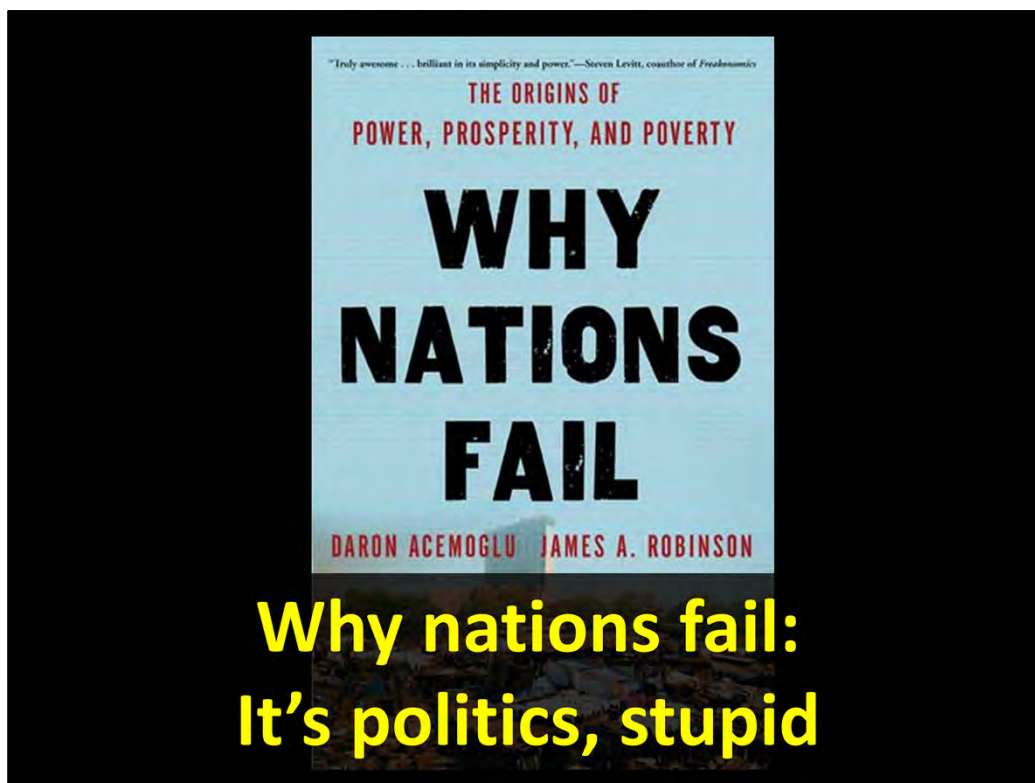
Most of this has been a failure. For example, there have been repeated evaluations of the effects of the huge amount of money which has been poured into technical cooperation, and they all find, without exception, that there is nothing to show for it. That hasn't stopped us from spending more and more on it.

One possible explanation for this is that we have not worked out which institutions



are most important for low-income countries. Depending who you listen to, we should focus especially on land tenure, property rights, public financial management, procurement, corruption, budgeting, independent government auditors, presidential term limits, civilian control of the army, management of natural resources, multi-party elections, judicial reform, public sector pay reform, results-based management, or leadership and training for Presidents' offices.

But if it is has been a problem that we do not know which institutions are important, it has been an even greater problem that we seem to know very little about how a country with weak institutions can best change them, nor whether there is any useful role that outsiders can play in supporting that process.



This is the most important new book on development published this year, called *Why Nations Fail* by Daron Acemoglu and James Robinson. The thing I like least about it is the title, because I think the interesting question is why some nations *succeed* in breaking out of poverty. The book gives a compelling account of why the governance agenda has, like previous grand narratives of development, not lived up to its expectations.

Acemoglu and Robinson say that mainstream development practice today is built on the incorrect assumption. We assume that poor countries are poor because their rulers have mistaken views of how to run their country: they prevent markets from working properly and they tolerate corruption. Development cooperation is based on the notion that we should try to engineer prosperity by providing the right advice and by convincing politicians of what is good economics. The reason that this is incorrect, according to Acemoglu and Robinson, is that poor countries do not have weak institutions because they do not know any better, but because it suits the powerful elites to run things this way. In other words, a country's institutions are not an externally-provided factor of production, like labour or capital, but an internally generated result of the country's politics.

I'm a bit torn about this book. Their description of how the politics of nations shape their institutions are fascinating. But in the end it seems to be another in a long line of books which spends a lot of time saying that everyone before them was wrong, and that there is some missing ingredient which would make things right.

## 50 years of development in four bullet points

**1. Fastest progress in history**

**2. No explanation for the difference**

**3. Missing ingredients?**

**4. All endogenous**

After this tour of development policy over the last fifty years what have we learned?

First, some countries have achieved the extraordinary take-off which we describe as economic development; and even in those countries which have not achieved economic growth there have been huge improvements in human welfare. The last fifty years has been the most successful period in history in reducing poverty, increasing incomes, getting children into school, improving life expectancy, reducing hunger and malnutrition, and increasing access to clean water.

Second, traditional economic models have a very hard time explaining why some countries experience rapid economic growth, after tens of thousands of years of relatively little economic change, and other countries do not.

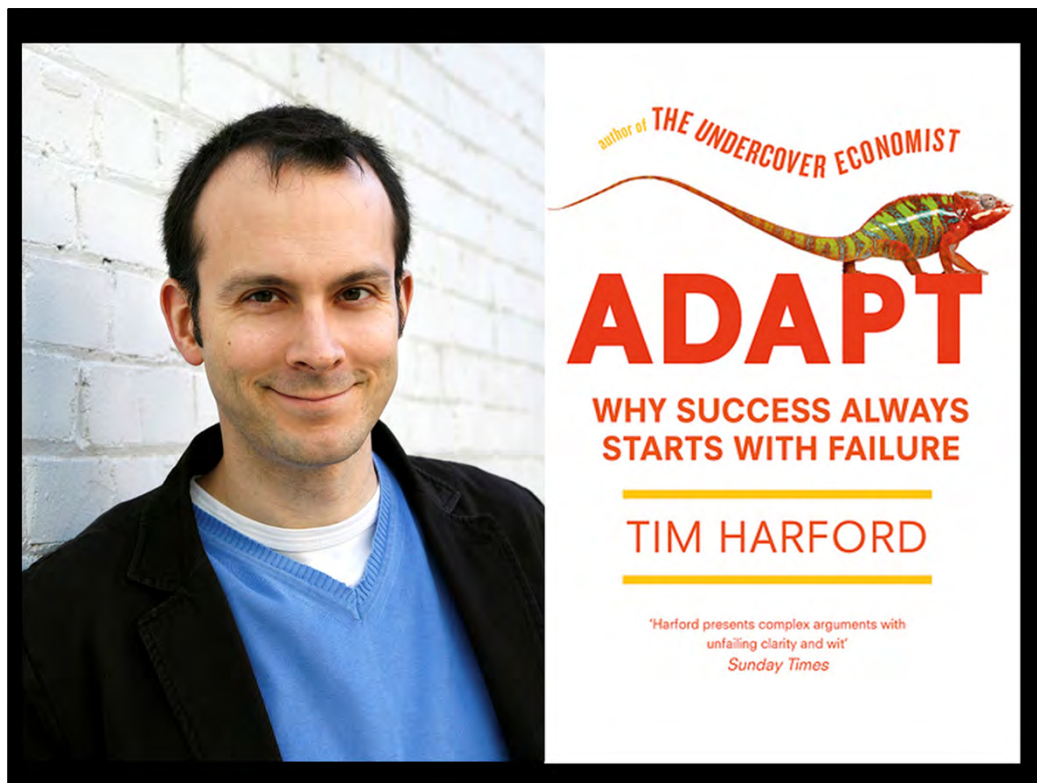
Third, we have repeatedly looked for some missing ingredient which is needed to enable economic growth. Candidates for this missing ingredient over the decades have included capital, technology, policies to make economies more efficient, better institutions and now, better politics. None of these efforts have succeeded.

Fourth, every time we think we have identified what's missing, we find that it is not something which can be provided from outside, but it turns out to be an endogenous characteristic of the system itself.

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But if there is no missing ingredient, why have some economies experienced economic lift off when others have not? That is the question to which we are now going to turn: and we are going to start by looking at the idea that economic, social and political progress happens through a process of adaptation and evolution.



The economist and writer Tim Harford published last year a very readable and compelling book called, *Adapt: why success always begins with failure*, which shows how every successful complex system we see in our world is the result of a process of adaptation or evolution of its components.

We are all familiar with how evolution has helped create a large number of improbably complicated biological organisms – from fruit flies to human beings. What Tim Harford shows is that similar processes are at work in many other part of our lives.

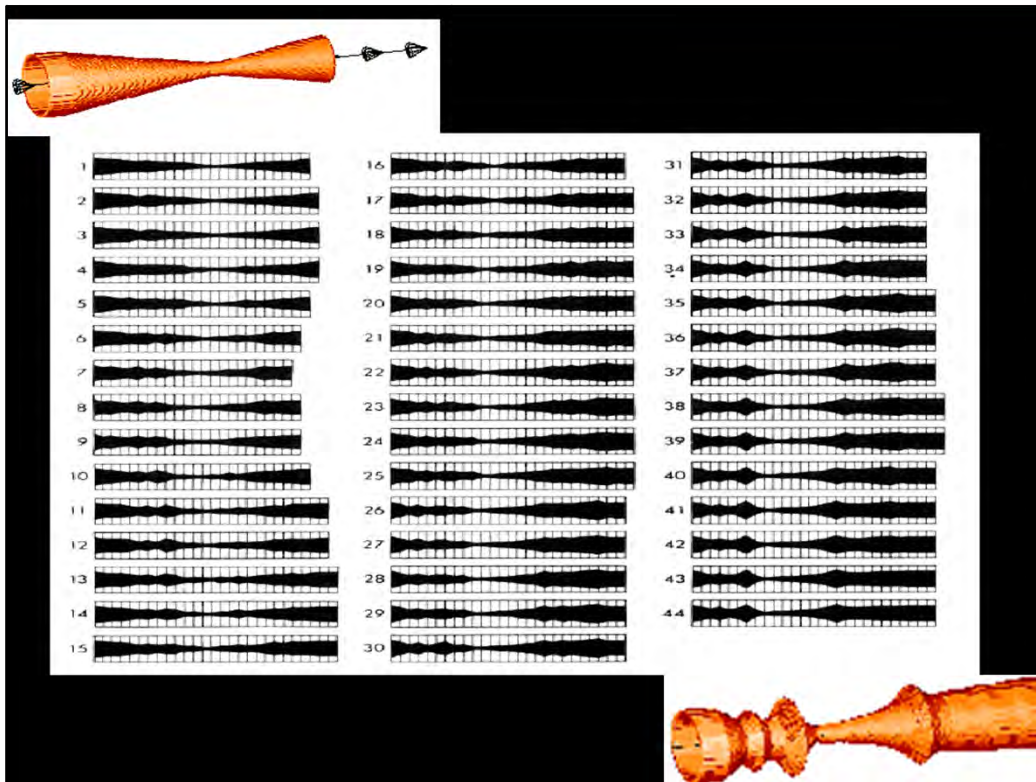
## Steve Jones



This is Steve Jones, who is now a famous evolutionary biologist. When he first started out on his career, he worked in a factory making soap powder. Now the process for making soap powder is that you mix together a bunch of the right chemicals in liquid form, and then you force the mixture out through a spray nozzle. This forces the soap powder to crystallise and it drops to the floor. You sweep that up, put it in a box, and then you sell it for a hundred times what it cost you to make it.

A critical component in that process is the nozzle, and Steve Jones was hired to help design a better nozzle. This was a problem that had been occupying a whole roomful of scientists at Unilever. The problem is that fluid dynamics are non-linear, and that makes all this fiendishly complicated to model.





So the young scientist tried a different approach. He took the existing nozzle, made ten copies, and then randomly distorted each of the ten copies. He tested each of the ten variants he had made, and measured which one worked best. He took ten copies of that, randomly distorted those ten copies, tested each of them, and so on.

After forty-five generations, the nozzles looked like this. Nobody could have designed this nozzle. In fact, to this day nobody can describe why it works. But it works much, much better than the nozzle they started with.

I expect some of you at some time in your career have been asked to find ways to make your organisation more efficient. In those kinds of situation, a 20% increase in efficiency would be regarded as pretty remarkable. This new nozzle is not 20% better than the original: it is hundreds of times more efficient.

That is a characteristic of adaptive change: it doesn't just bring about small improvements; it often brings about startling, game-changing jumps to new solutions, like the evolution of the eye for example in biology.

## Products adapt



190 years of adaptation so far



*This point comes from Eric D. Beinhocker, 'The Origin of Wealth'*

Steve Jones and his nozzle were working on just one component in the production of soap powder, the nozzle.

Now look at this: this is the bicycle. The key thing is that no single person invented the bicycle. When the Victorians had access to the materials to make a good bicycle – steel for the frame, rubber for the wheels, machines to make chains and gears – they tried all kinds of options. You've probably seen big Penny Farthing bicycles, which turned out not be very efficient and not very comfortable. Even now, with today's physics and computing power, you could not design a perfect bike from scratch: it is too complicated you have to try many different varieties and changes and see which work best.



## Firms (or industries) adapt



The notion of survival of the fittest and evolution is already familiar in economics in the idea that firms and industries adapt and evolve. The idea goes back to Schumpeter and his idea of *creative destruction*.

But it is important to keep in mind the distinction between *firms* adapting and *industries* adapting. Think about Nokia, for example. Nokia began as a manufacturer of tyres and rubber boots. It later got into the telecommunications business and it did so very successfully. So it is a good example of how a *firm* can adapt to new opportunities. But more recently Nokia has not really made the transition yet from phones to smartphones, and so it has been overtaken by Samsung as the world's largest manufacturer of mobile phones. It is not clear today if Nokia will be able to repeat its earlier success of adapting to a changed environment, or whether it will end up going out of business. 80% of productivity improvement does not come from within firms, but from the creative destruction process in which old firms go bust, and then they are replaced by new firms which are better adapted to today's environment.

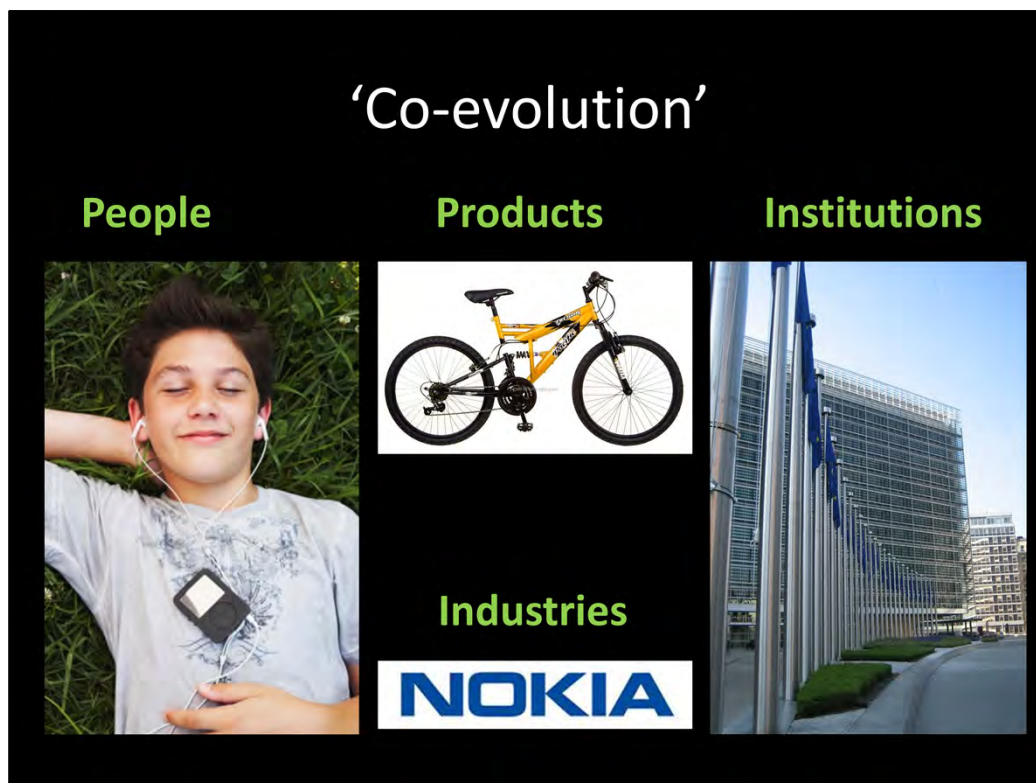
## Institutions adapt



Nor is there anything new in the idea that social technologies evolve. In his book in 1976, *The Selfish Gene*, Richard Dawkins invented the word 'meme' to describe the way that ideas, habits and cultures can replicate and evolve.

Economies and societies are governed and served by various kinds of institution which have also evolved. Some of these are quite explicit – things like contract law or the rules of intellectual property. Some of them we take them for granted – things like money and policing.

And then there are other rules and institutions we not be aware of at all but might still be very important for the success of a society and economy – for example, cultural norms about trust and reciprocity or kinship.



The point is that in a complex economy and society, there are a very large number of adaptive processes going on.

*People* adapt: their tastes and habits and perhaps even their psychology and physiology change in response to changes in their circumstances.

And we’ve seen that *products, firms, technologies, institutions* all adapt and evolve.

Importantly, these all interact with each other as they evolve. I don’t just mean that firms interact with firms, and institutions with institutions, although that is true. The point is that these different technologies all *co-evolve*.

For example, changes in technology have led to greater use of online retailing. That has been good news for Amazon, but bad news for Borders. So that’s an example of how an industry has adapted to a change in product and technology. As online shopping has increased, and cars have become cheaper, so many High Street shops have gone out of business. That leads to a change in our environment – it changes the nature of our city centres, and how people spend their leisure time. That in turn is leading to changes in public policy – for example, changes in the planning regulations – to try to revitalise those town centres. So you can see that there is this constant process of adaptation changes in physical technologies, people’s behaviour, business plans and firms, social institutions, the environment in which we live – all changing in response to each other.

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So we can think of the economy and society as being composed of a rich set of interactions between a very large number of adaptive agents, all of which are co-evolving. These are the classic circumstances which create what physicists and biologists call *Complex Adaptive Systems*.

# Complex Adaptive Systems



## THE ORIGIN OF WEALTH

*Evolution, Complexity, and the  
Radical Remaking of Economics*

ERIC D. BEINHOCKER

HARVARD BUSINESS SCHOOL PRESS

I'm not going to do justice to the theory of Complex Adaptive Systems in this presentation. If you want to know more, I recommend you get this book, *The Origin of Wealth*, by Eric Beinhocker. Also next year Ben Ramalingam has a book coming out about complexity and development.

## Complex Adaptive Systems

It is a bit like going to the zoo and talking about the 'non-elephants'.

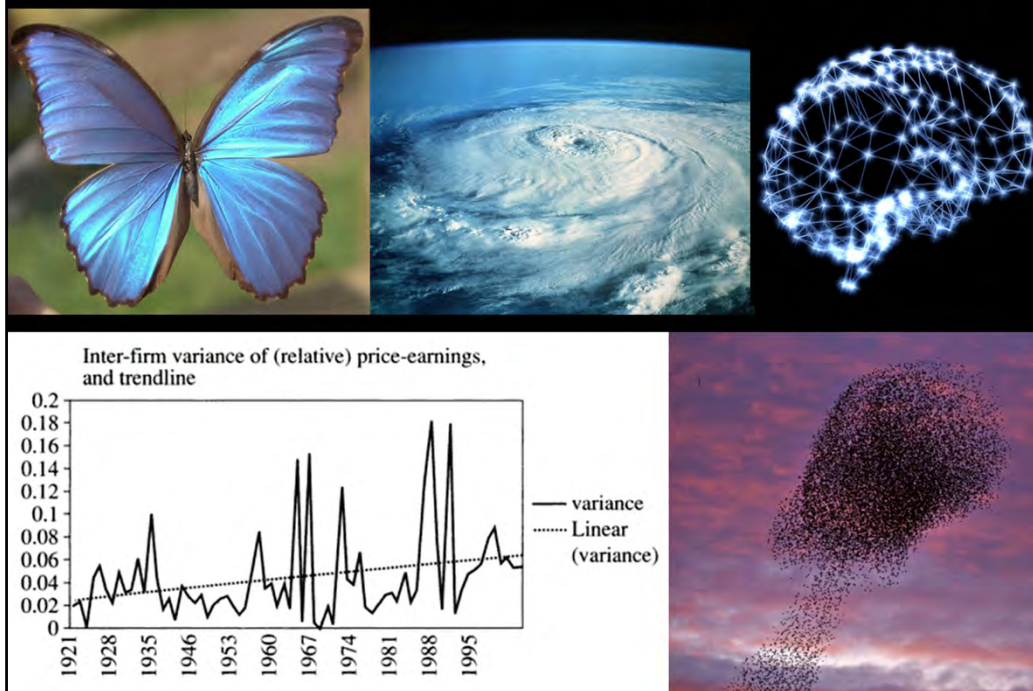
The normal state of affairs is not linear systems, but complex non-linear systems.

Economists have typically ignored the obvious truth that the economy they are trying to model is complex and non-linear. Fortunately, physicists and biologists have been studying complex adaptive systems for more than three decades. It turns out that there are lots of examples of these systems all around us: biological organisms, ecosystems, rivers, the human brain, flocks of birds, the climate and weather.

In fact, it is strange that we are talking about non-linear systems at all. It is a bit like to the zoo and talking about the non-elephants we find there. The normal state of affairs is not linear systems, but complex non-linear systems.



# Complex Adaptive Systems



Obviously all these systems are all very different. The human brain does not appear to have much in common with a weather system. But the more we have studied these systems, the more we are finding that there are certain similarities between them, which are the consequence of the mathematics of the way these *adaptive agents* interact with each other in a complex adaptive system.

I am going to list five important feature of complex adaptive systems:

**First, they are all difficult or impossible to predict in detail** . This is often called the butterfly effect – the idea is that in a non-linear system, a small change in one part of the system, such as a butterfly flapping its wings, can set off a chain of events which leads to a change somewhere else, such as a hurricane on the other side of the world.

**Second, you can make broad brush predictions about the system as a whole.**

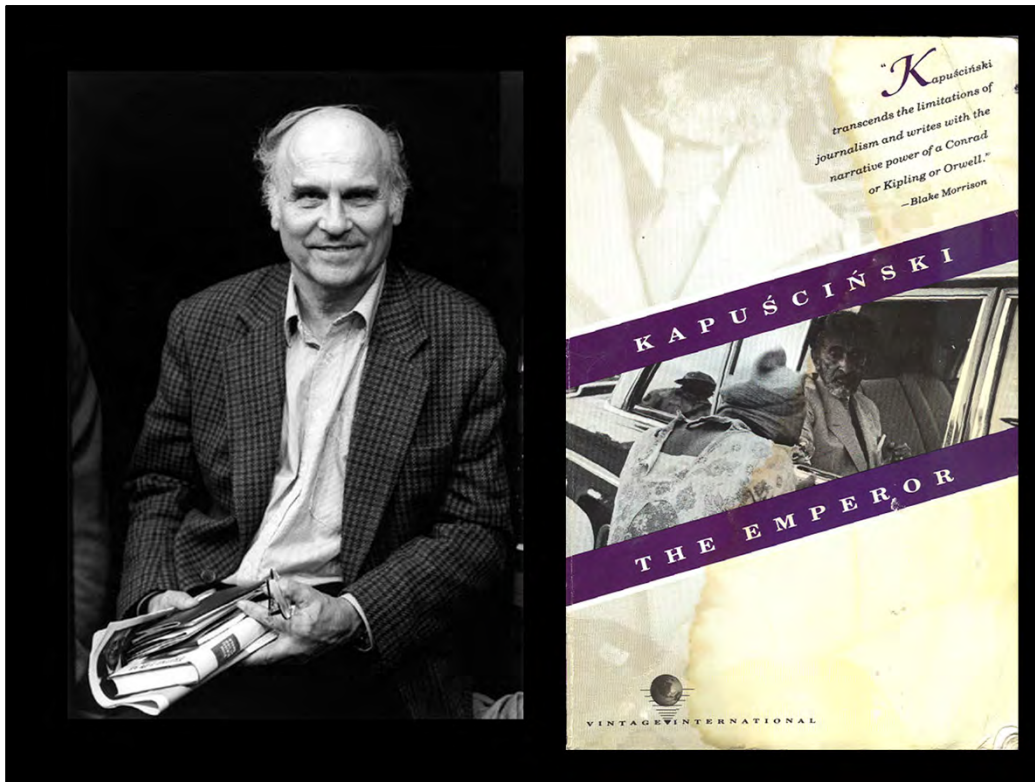
Though the detail is unpredictable because of the butterfly effect, complex adaptive systems will usually show patterns of self-organised global order. While you cannot say whether there will be a thunderstorm on a particular day in London, you can describe roughly what the weather will be like in London in July.

**Third, complex adaptive systems have *emergent properties*** - that is, there are patterns within the system which are not specifically linked to any individual agent within it. The consciousness of the human brain is a characteristic of how the different brain cells interact with each other, but it would make no sense to say that a particular cell is, or is not, individually conscious. Similarly, a thunderstorm is an emergent property of the atmosphere: you cannot say that any particular water or air molecule is in a stormy state – it is the way the molecules interact with each other which gives you the thunderstorm.

**Fourth, complex adaptive systems tend towards greater complexity.** This is quite the opposite of most economic models, which tend towards simplicity and equilibrium. Biological evolution did not lead to convergence on a single species. Think about the complexity of a developed market economy: the Argos shop I visited earlier in this presentation sells around 25 thousand different products. In a large city like New York or London there are perhaps 10 billion different products on sale. Because the evolution of products and firms happens faster than biological evolution, there are vastly more different products than there are biological species on the planet.

**And fifth, these systems do not tend towards an equilibrium.** Generally, the global patterns in a complex adaptive system tend to be stable for relatively long periods of time and then unexpectedly make fast, large changes. One way to understand this absence of equilibrium is to think about the process of *coevolution*. Each agent in the complex adaptive system of the economy is evolving in the light of the environment it faces. But the evolutionary pressures are other agents, which are themselves adapting and evolving. This combination of co-evolution and time-lags means that there is no equilibrium towards which the economy as a whole is moving.





I had the honour of giving this talk as part of a lecture series named after the great Ryszard Kapuściński. The book which made Kapuściński famous outside his native Poland was *The Emperor*, which chronicled in beautiful, vivid detail the last days of Emperor Haile Selassie, the last of the great feudal dynasty of Ethiopia which ruled until it was overthrown in 1974.

Using a combination of historical accounts and fictional narrative, Kapuściński makes the court of Haile Selassie sound like something out of a dark fairy tale. Each morning the Emperor would stroll around the palace grounds feeding wild lions, while his secret police gave him reports from his network of informers. Then came the Hour of Assignments, at which Ministers and officials were promoted and demoted, and then the Hour of the Cashbox. A servant was assigned to carry the Emperor's lambskin purse, another to polish the shoes of visitors. All decisions came from the Emperor, all questions came from the top down. In the feudal kingdom of Ethiopia, it was dangerous to tell the Emperor about poverty and starvation in the countryside.

Writing about Ethiopia, Iran and Angola, Kapuściński gave us a compelling account of the internal logic of these regimes, which existed by extracting economic value from their population, and by suppressing any efforts to move towards more inclusive

political and social institutions which might threaten their position.

Please don't misunderstand me: this is not a simplistic point about the value of democracy. If you have been paying attention to the economic transformation of China, you will know that there is more to the story than western-style democracy. But it is also hard to avoid the conclusion that Ethiopia has been stuck a kind of a poverty trap. It had a rich and powerful elite, which benefited from the prevailing economic structure, which was able to suppress the co-evolution of more plural and more equal economic and social institutions.

This is a variation on the familiar problem of the resource curse. When countries have oil or other natural resources to sell, the powerful elites are able to control these revenues, and use them to sustain their power. They have no interest in seeing the economic or political systems evolve, and they use their power to prevent it from happening. When the mechanisms of adaptation and co-evolution are stifled in this way, you don't get the emergence of systemic change and self-organising complexity which is what we call development.

# Outline

1. The toaster project
2. Conventional economic models
3. Adaptation and coevolution
4. Complex adaptive systems
5. **Seven policy implications**

The story so far is that the economy is part of a complex adaptive system, and that development is what is called an '*emergent property*' of that system. The countries we call 'developed' have experienced a largely spontaneous rapid change to a more complex, self-organised system which does a better job of supporting the capabilities of their citizens. But something about the dynamics of the system in other countries means that this change has not yet occurred. One possible explanation is that adaptation and change are suppressed by powerful elites who have nothing to gain, and everything to lose, from a process of creative destruction.

What does all this mean for people who are trying to change their economic and social systems, and those of us who want to try to assist that from the outside?

I am going to try to suggest seven policy conclusions from this analysis.

# 1. Resist engineering



The first policy conclusion is to that it is very difficult to engineer solutions in a complex adaptive system.

There are two reasons for this.

First, at the level of specific improvements, evolutionary processes often outperform design. To see this, think back to Steve Jones, the biologist, who was able to bring about a massive improvement in the production of soap powder in a way that a room full of engineers had failed to achieve. It is partly that the problem is technically difficult to solve, but it is also that each product, industry and institution has to adapt to and change with the particular environment it is in.

Second, at the level of the system as a whole, the non-linear dynamics means that it is generally impossible to predict what will happen as a result of any particular change. That makes engineering solutions almost impossible.

This means that instead of trying to replace evolutionary processes, as the former command economies tried to do and as the development industry tries to do today, we should be trying to harness them.

## 1a. Avoid isomorphic mimicry



An example of what we should try *not* to do is the approach we have generally adopted for institution and capacity building. If you have lived and worked in a developing country this will be a horribly familiar problem.

You know that situation where a group of well meaning aid donors comes along and says: what you need is radical reform of some key institution? Perhaps it is the health ministry or the tax office. The donors then draw up a blueprint for everything that is needed, which they label with the chilling words '*international best practice*'. They come along with a budget, an organogram, and a mission statement. The result, all too often, is an organisation that looks as if it *should* work, but it does not. It has all the organisational characteristics of a well-functioning institution, but it does not connect to, or change with, its environment.

My colleague at the Center for Global Development, Lant Pritchett, has called this problem '*isomorphic mimicry*', which is another idea taken from evolutionary theory. Apparently animals sometimes evolve the appearance of being more dangerous than they really are. If you can avoid being eaten by predators simply by *looking* poisonous, that may be a better option than actually *being* poisonous, which may require additional energy. Similarly in development it is easier to create an organization that *looks like* a police force—with all the organizational charts, ranks,

uniforms, buildings, weapons—than it is to create an organization which can actually enforce the law.

The point is that when donors come along and say they want to support institutional development, they create a powerful new evolutionary pressure to generate not functional organizations but institutions which can adopt the camouflage of capable organizations even though they have none of the associated drive for performance.



## 2. Resist fatalism



The second policy conclusion is that we must resist fatalism.

It is true that biological evolution has been a largely mechanical process, with a *tempo* set by the process of sexual reproduction and random mutation, and a *direction* determined by survival of the fittest.

But that does not mean we have to accept whatever outcome the process of evolution gives us. On the contrary, if we are smart then we can both accelerate and shape evolution.

This is Norman Borlaug, the man who brought about the Green Revolution by intervening in the evolutionary process to develop high-yield, disease-resistant wheat varieties.

He increased innovation using crossbreeding and then selected actively for high yield varieties. By doing so he is estimated to have saved more than a billion people round the world from starvation.

Think back of the evolution of the bicycle. The criteria for selection and replication were not the ability to survive long enough to reproduce, as they are in biology. People want bikes which are fast, comfortable, safe, convenient, and cheap to make. So the selective pressure imposed by the market on bike manufacturers was to produce bikes with the best possible combination of these characteristics.

### 3. Promote innovation

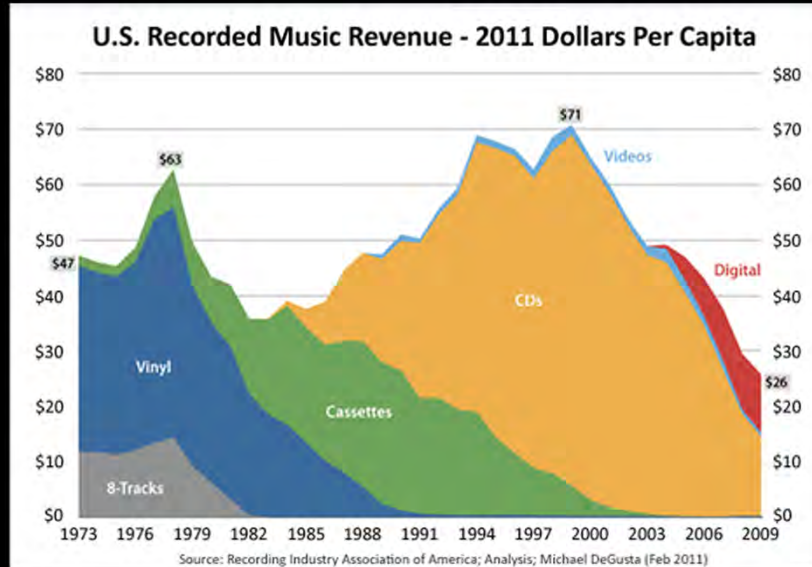


Are there characteristics of the system which tend to promote, or tend to dampen, *innovation*, which is a key part of the adaptive process?

People on the right are likely to emphasize encouraging entrepreneurs, protection of property rights, ownership of assets, access to financial services, the absence of corruption, laws of limited liability and joint stock companies, and keeping government bureaucracy out of the way of entrepreneurs.

Those who lean to the left might observe that more equal societies are more pluralist and less susceptible to capture. People are likely to be risk takers if they have the support of a safety net or a national insurance scheme. Innovation, which is a public good, may depend on well-organised publicly-funded research and development. And perhaps there is a role for the state in helping to create the conditions in which firms and industries can get started as part of a strategic industrial policy.

## 4. Embrace creative destruction



But it is no use having all this innovation unless you also have selection.

The system has to incorporate feedback loops which promote adaptation suitable to that environment.

The failure of the command economies of what used to be called the second world, and the autocratic regimes of what used to be called the third world, is probably attributable in large part to the absence of effective feedback mechanisms to force performance in economic and social institutions.

Again, your priorities may depend on your political instincts. If you are on the right, you may emphasize the need for open and competitive markets, which reward success and punish failure. State subsidies and trade barriers are the enemy of creative destruction because they shield poor performers from the consequence of their failures.

For people on the left, barriers to economic adaptation are just as likely to be the behaviour of a rich and powerful elite who benefit from the status quo and so resist any kind of creative destruction. A good example is the music industry, which has fought a tough campaign to prevent every single one of the changes shown on this graph. On this view, it is important to challenge any concentration of wealth and power which may be an obstacle to change. Incidentally, the development industry itself has some organisations who fall into this category.

It is important to think of this process not just in the economic space but in the political space as well. It seems likely for example that the process of political change will be improved by a free media, access to information, transparency of both government and business, and a strong and transparent civil society movement.

## 5. Shape development



Clearly it is desirable that there are effective mechanisms for innovation, and that there is effective feedback and selection to accelerate the process of adaptation. But the fifth policy conclusion is that it is desirable that the fitness function which that selective pressure enforces represents the goals and values of that community. For example, if you are in a society with more economic equality and greater political pluralism, you will tend to put pressure on economic and social institutions to evolve in directions which meet a broader range of needs than would be the case in a more unequal society.

To caricature a bit, people on the right tend to focus on the need for innovation and selection to accelerate evolution, but they pay too little attention to the need for society to shape its direction.

And people on the left tend to pay too much attention to the need to determine the destination in which the process is heading and pay too little attention to nurturing the dynamism and creative value of the evolutionary process.

## 6. Embrace experimentation



The sixth policy conclusion is that we should explicitly embrace the idea of greater experimentation as a component of the development process.

There is a bit of a movement now which rejects the common development view that there is a simple, replicable prescription for development: consisting of market-friendly policies, outward orientation, social policies which build human capital and good government.

Dani Rodrik, for example, talks of 'one economics, many recipes'. David Booth talks of the move from 'best practice to best fit'. Mirilee Grindle talks of 'good enough governance'. Lant Pritchett, as I have already discussed, talks of the dangers of isomorphic mimicry. Bill Easterly has talked of moving 'from planners to searchers'. I have call for us not to design a better world, but to design better feedback loops.

This orientation towards experimentation makes enormous sense in a complex adaptive system. The properties of these systems are emergent, not predictable in advance. As with the much simpler problem of designing a nozzle to make soap powder, the most promising way to grope towards improvements in those systems is to make small changes, see what happens, and then adjust.



## 7. Act global



Seventh, there is a lot we do not understand about how, or even whether, we can shape the dynamics of economic, social and political evolution in other countries.

A good place to start might be to make a bigger effort on the things we can control.

If we believe that *open and accountable institutions* are important, we could make a bigger effort to reform international institutions of which we are part. We still participate in processes to appoint leaders of international organisations based on stitch-ups behind closed doors.

If we believe that *trade* is important, we could do more to open our own markets to trade from developing countries.

If we believe *property rights* are important, we could do more to enforce the principle that nations, not illegitimate leaders, own their own natural resources, and that anyone who buys oil or minerals from unelected governments is guilty of handling stolen goods.

If we believe *transparency* is important, we could start by requiring our own companies to publish the details of the payments they make to developing countries.

If we believe the *rule of law* is important, we could entrench those rights more firmly in our own systems, and resist the temptation to make exceptions in the name of political expediency.

If we believe *openness and exchange of ideas* are important we could do more to welcome the movement of people around the world, instead of making it more and more difficult for people to migrate temporarily or permanently from one country to another.

We do have one striking success in the realm of spreading social and political change: and that has been the process of European Union accession. This was a case of European governments agreeing a set of norms and values by which to conduct their affairs with each other, and then providing support to other countries to enable them to join the club.

I am not arguing that these are necessarily more important than what countries do themselves to change their own systems. But they are at least changes over which we have some control, and which are ours to make.





I am conscious that there are a lots of different ideas in this presentation, and I'd like to pull them together into two big statements.

First: the economy is made up of adaptive people, products, firms and institutions, which means that it behaves as a complex adaptive system. Development is not a series of individual successes but a property of the system as a whole. It is the emergence of self-organising complexity.

Second: development policy should not try to look for missing ingredients or try to engineer poverty reduction. It should try to harness the strength of adaptation and complexity. It should embrace experimentation and look for ways to nurture the adaptation and evolution which may help to bring about change in ways which not only accelerate evolution but also shape it consistent with social values and goals.



Looking back on our well-intentioned efforts over the years, it seems to be clear that we assumed too readily that progress would be linear and predictable. This means that we were not prepared for, nor did we have the tools to understand, emergent phenomena such as climate change, the global financial crisis, nor the tools to explain why some countries have been able to achieve extraordinary rates of growth. As the global system becomes more interconnected, so it becomes more and more important for us to understand complex economic and social systems, and for us to find ways to shape them.

I hope it is clear from all I have said that we should approach this task with humility. We have been wrong before. If economic and social change are the results of a complex adaptive system, this does not mean we have to accept whatever is served up to us. But it does mean that we cannot engineer success; we have to proceed in small steps, experimenting, learning and adapting alongside all the other parts of the system with which we are co-evolving.

This young lady aspires to be a doctor. But she is just one person in a complex system, and her prospects depend not only on her own efforts, but on whether the society in which she lives gives her that opportunity. As we come to understand the dynamics of development better, let's hope that we will do what we need to do to help her to fulfil her dreams.

Thank you

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